FINAL PROGRESS REPORT

Title: Using Health Information Technology to Support Population-Based Clinical Practice

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STRUCTURED ABSRTACT

Purpose:
Clinicians and healthcare consumers can benefit from timely, easily accessible, and region-specific information about infectious disease activity. Such information has the potential to improve decision making in the context of common conditions accounting for a majority of acute, ambulatory healthcare utilization and are associated with threats to patient safety (unnecessary antibiotics, adverse drug events) and satisfaction (complaints relating not getting an antibiotic).

Scope:
Develop health information technologies that provide information tailored to the needs and work flows of clinicians and healthcare consumers.

Methods:
We used focus groups with clinicians and parents of patients, structured observations and contextual interviews with practicing clinicians and iterative design principles to develop multiple approaches for disseminating information about infectious disease activity in Utah.

Results:
Over 5+ years, we developed a collection of technologies: an automated data collection system; information displays; a provider-facing web site and iOS application; an email distribution list with >500 individuals (clinicians, public health partners, school nurses, HR managers, administrators) receiving weekly updates; a public-facing web site and companion mobile application; a partnership with local news media to disseminate the “viral weather report”; and a process for using social media to engage consumers in discussion/education about ongoing and upcoming outbreaks.

Key Words:
Acute Respiratory Infections, Health Information Technology, Population-Based Clinical Practice, Mobile Health, Data Visualization, Consumer Health IT

PURPOSE

SPECIFIC AIMS

This body of work directly addressed AHRQ's research priority to improve health care decision making by developing, implementing, and integrating health information and decision–support tools for ambulatory clinicians. The overall aim of the proposed research is to demonstrate the value of HIT—as a means to improve primary care physicians' adoption and use of population-based clinical practice principles—by providing them with decision support tools that deliver integrated population-level data and clinical knowledge to the point-of-care. We proposed to demonstrate HIT value through the following aims:

Aim 1: Assess primary care clinician use of current population-based ARI health information resources and decision support tools using focus groups and structured observation.

Aim 2: Refine population-based ARI health information resources and decision support tools to improve clinical information system workflow integration and patient communication.

Aim 3: Implement these population-based ARI health information resources and decision support tools in primary and urgent care settings.

Aim 4: Measure the effects of population-based ARI health information resources and decision support tools on population-based clinical practice and patient/parent compliance.

SCOPE

BACKGROUND:

Acute respiratory infections (ARI) have an enormous impact on population health and ambulatory health care use. Antibiotic use for ARI in primary care settings is excessive and linked to the emergence of antimicrobial resistance and adverse drug events. Despite decades of intense efforts to educate patients and clinicians about evidence-based guidelines, they continue to ignore the substantiated facts that show little or no benefit from antibiotics for common ARI. Various quality improvement efforts have been shown effective at reducing antibiotic use in ambulatory settings, although there is still much room for improvement. Physician-parent and -patient communication is fundamental to improving care in ARI.

Importance of population-based principles in clinical practice of ARI. Health services researchers and policy makers have argued for the adoption of population-based principles in clinical practice. Five population-based principles that are highly relevant to ARI include 1) a community perspective, 2) a clinical epidemiology perspective, 3) evidence-based practice, 4) an emphasis on outcomes and 5) an emphasis on prevention. When mapped to the problem of ARI, the potential benefits of principles for effectively managing ARI becomes readily apparent. Consider the orientation of a typical ambulatory primary care clinician faced with making diagnostic and treatment decisions for a patient presenting with ARI, especially in the middle of winter when multiple viral pathogens co-circulate. The physician would benefit from knowing the following principles:

a) A community perspective: Knowledge of respiratory viruses circulating in the community and social structures that facilitate transmission. Risk factors for patients and the community.
b) A clinical epidemiology perspective: Knowledge of clinical epidemiology of specific viruses including the signs and symptoms, the typical natural history of infection, the risk for a complicated course and what diagnostic testing is useful for detecting/differentiating them.
c) Evidence-based practice: Knowledge of guidelines for antibiotic use in ARI and efficacy of over-the-counter cough and cold remedies.

d) An emphasis on outcomes: Knowledge of effective techniques for educating patients about viral diagnoses and the risk / benefits of treating them with antibiotics and OTC remedies.
e) An emphasis on prevention: Knowledge of available prevention strategies and how to apply them.

Role of population-based data in population-based clinical practice. The knowledge base required to support clinical decision making for ARI is highly dynamic. The local incidence and the pretest probability for individual pathogens varies based on their endemic or epidemic activity level. Recommendations and target populations for vaccine preventable diseases change frequently, Recommendations for antiviral use for influenza can change from season to season or even in the same season.

Supporting the population-based principles outlined above requires timely, population-based information that is clinically relevant, generated by a trusted source, locally applicable, and readily accessible. Physicians need decision-support tools to translate surveillance data, individual practice data, and clinical guidelines into an organized clinical response. Novel methods to increase clinicians' use of population-based practice principles are urgently needed. Use of surveillance reports and visualizations of local disease activity—coupled with data about their individual practice patterns and recommendations about diagnosis, prevention, and treatment—provide a signal to population-based practice that has not been evaluated. Data are being collected and resources are being generated. This deficit is a result of our failure to effectively communicate this information where it is most needed most--the front lines of health care.

Health information technology for supporting population-based clinical practice. Annual outbreaks of ARI (bacterial and viral) are responsible for the majority of outpatient health care visits, and a large portion of hospitalizations in the US. The overuse of antibiotics for viral respiratory conditions has been linked to antibiotic resistance and represents a critical problem for our nation's public health. The problem of antibiotic overuse has been well documented, yet solutions to this problem have been only moderately successful, difficult to sustain, underdeveloped, and understudied. New approaches are urgently needed.

We believe that by providing physicians and their patients with timely and easily accessible information about the local incidence of common respiratory viruses will improve their ability to distinguish viral infections from bacterial infections and lead to more effective antibiotic prescribing in the context of ARI. We also believe that evolving information technologies can support novel and sustainable approaches to delivering timely, population-based health information about ARI to front line clinicians at the point-of-care.

Although health care delivery organizations have access to robust technologies that can handle huge repositories of data, little progress has been made in using that information effectively. A rapidly emerging new direction—applying information technology to support business processes including healthcare delivery—is the development of information dashboards. An information dashboard has been defined as *a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance*.[69]. When patients present with acute infections of the upper and lower respiratory tract, the medical care objectives are to provide the best possible care at the lowest reasonable cost. The best possible care includes cost effective diagnostic practices and therapeutic applications that minimize patient harm and maximize patient benefit.

Circumstances have recently combined to create a timely opportunity for using dashboards to add value to the practice of clinical medicine. These include advances in data warehousing and online analysis infrastructure, an emphasis on performance management and metrics, technologies

such as high-resolution graphics, and a growing recognition of visual perception as a powerful channel for information acquisition and comprehension. Effectively harnessing these technological advances and integrating them into clinical information systems and health information technology more broadly (e.g. patient portal and personal health records), has the potential to transform the current paradigms of health care delivery. With respect to the ambulatory care of ARI, the best paradigm is one where the health care provider and the patient are looking at the same information on a computer screen and the provider is saying "let's see what's going around in your community that could be making you cough and discuss the best way to help you get better and protect your friends and family."

CONTEXT:

This work was conducted utilizing clinical data routinely generated during healthcare delivered in an integrated delivery system including 23 hospitals and >100 clinics located in the Intermountain West (Intermountain Healthcare, Utah).

SETTINGS:

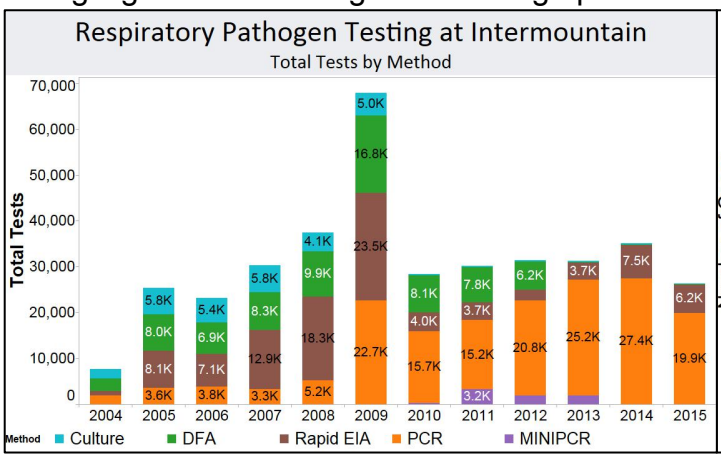
The clinical settings of providers we targeted were Family Practice and Internal Medicine Clinics (~60 clinics), Urgent Care Clinics (8 pediatric and 27 adult), Pediatric Clinics (~20) and Emergency Departments (21).

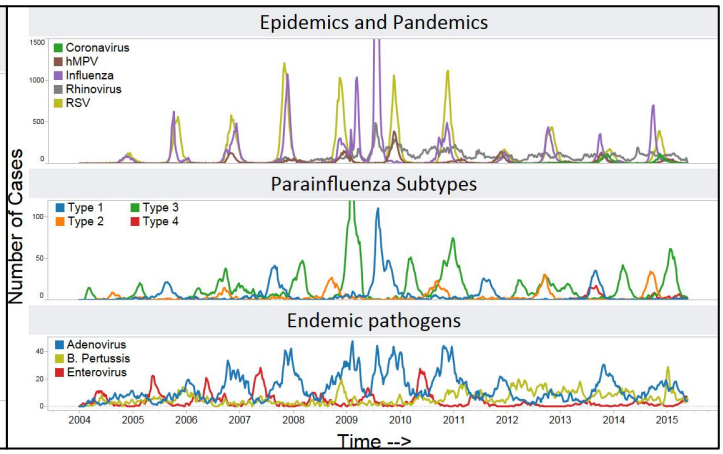
PARTICIPANTS:

The clinician participants (structured observations, semi-structured interviews, and iterative design cycles) were a mix of primary care specialties (e.g., Internal Medicine, Pediatrics, Family Practice and Emergency Medicine) and adult and pediatric infectious disease experts. We also drew upon various administrative stakeholders including chief medical officers, hospital and clinic administrators and infection control practitioners.

INCIDENCE/PREVALENCE:

The above clinics from the Intermountain Healthcare system see roughly 200,000 patients (~40% pediatric) for Acute Respiratory Infections (ARI) each year. Testing for respiratory pathogens by various methods is performed roughly 30,000 per year throughout the system of hospitals and clinics. The majority of testing is done by multiplex PCR which tests for a panel of respiratory pathogens. The majority of the testing is done on patients sick enough to be cared for in the emergency department or in the hospital. This volume of patients and extent of testing provides a strong signal for detecting and tracking epidemics.

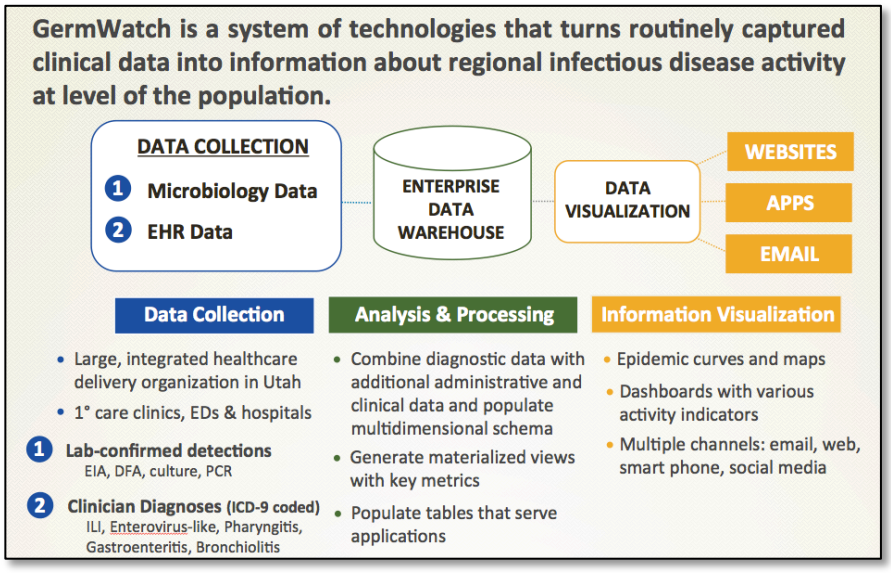




METHODS

PROJECT DESIGN

The overarching objective of this project was to further the development of an innovative health information technology program – titled GermWatch – that is transforming healthcare delivery in Utah. The GermWatch program comprises state-of-the-art molecular microbiologic diagnostic platforms, healthcare data warehousing systems, business intelligence and information visualization applications and multiple information dissemination channels (web sites, e-mail lists, smartphone applications, social media and regular media partnerships). The process we followed was to gather user requirements (clinicians and patients/parents of patients), design new tools and refine/enhance existing tools to meet these needs and then iteratively develop and deploy them.



DATA SOURCES AND COLLECTION

To gather user requirements, we used the following methods and sources.

Structured observations and contextual interviews with clinicians

To gain in-depth insights into the current knowledge gaps between the perceived use of PBD in clinical practice and actual use in clinical practice we conducted structured observations and contextual interviews with 12 clinicians from 6 different practice sites (2 urgent care, 2 family practice, 2 pediatric). I spent a total of ~36 hours observing ambulatory clinicians caring for patient's presenting with ARI and afterwards used probing and open-ended questions to elicit the information needs of clinicians, their perceptions on the information needs of parents / patients, their use of the GermWatch tools in practice and solicited their ideas for improving the tools.

Focus groups with parents of patients

The focus groups were conducted to look at the perceived considerations of parents with children that have experienced ARI related health problems and possible avenues for information dissipation. Two focus groups were conducted with parents that have children that have received medical attention for an ARI within the Intermountain primary care delivery system:

More Experienced Parent Group: This group consisted of parents of children that have frequently experienced respiratory illness and symptoms. The number of children per parent ranged from 3 to 7 with an average of 4 children.

Less Experienced Parent Group: This group consisted of eight first time parents with children ranging from six months to 3 years old. The children have been to the doctor for respiratory related health problems ranging from as early as three weeks to 7 months prior to the focus group.

We used a combination of guided questions and open discussion to elicit thoughts and ideas about their response to symptoms, their frustrations with healthcare encounters, information sources and needs, suggestions for how to improve the system and their reaction to the GermWatch concept.

USER REQUIREMENTS SOLICITED FROM CLINICIANS

Enhanced data visualizations to support situational awareness: clinicians felt the graphs needed to do a better job of emphasizing predominant circulating pathogens and conveying the relative activity of individual pathogens. They requested visualizations that would convey, at-a-glance ("like the stock market app on my phone"), whether a specific pathogen's activity level was increasing, decreasing or staying the same. They wanted a concise representation of activity across the various 'regions' of Utah, so they could tell whether certain parts of the state were seeing more or less without having to reference a map (that would take up a lot of space on the display). They wanted to view historical outbreaks for comparative analysis (was this year as bad a last year) that could inform how busy they could expect to be. Recognizing that viral testing results were just the tip of the iceberg, they wanted better measures or signals for assessing the magnitude of various outbreaks on the community. For example, tracking the number of patients with a clinical syndrome like Influenza-like illness or strep pharyngitis.

They requested **information that would support pathogen-specific preparation and decision-making**. For example: 1) easy to access and up-to-date recommendations for antiviral use and priority immunization groups during influenza season, 2) guidance about immunoprophylaxis during RSV season (indications, when to start/stop). They also requested information about diagnostic testing: what tests are available, how much do they cost and for whom is testing indicated. Our clinicians were also very interested in information about the clinical epidemiology various pathogens detected/tracked by the GermWatch system. They wanted to be able to quickly update their knowledge of the epidemiology of various pathogens (especially unfamiliar pathogens that were recently included as part of the diagnostic testing panels, like human Metapneumovirus).

During my interviews and observations, an additional theme emerged that we had not anticipated. Clinicians expressed the **need for information about regional antibiotic resistance patterns** – antibiograms – for common bacterial pathogens isolated from ambulatory patients. An antibiogram is the result of a laboratory testing for the sensitivity of an isolated bacterial strain to different antibiotics. Most hospitals publish antibiograms summarizing data about antibiotic sensitivity of bacteria isolated from their inpatients on a yearly basis for their specific facility. These reports typically contain little or no information about specific patient populations (adult vs. pediatric, inpatient vs. outpatient, hospital vs. community acquired infections), specific conditions or syndromes or the relative frequency of various bacteria isolated from these populations. Aggregating microbiology data from multiple care settings, augmenting the data with additional clinical information and developing effective dissemination strategies for this information has the potential to better support clinical decision making with respect to empiric antibiotic selection.

Clinicians Perceptions of the Information Needs of Patients and Parents of Patients

Clinicians in our sample articulated the need for tools that facilitate shifting the focus of their discussions with patients from the need for antibiotics or diagnostic testing to effective symptom management. Most clinicians felt comfortable being able to identify fairly early on in the visit that the patient was experiencing a viral illness but thought that there was a roll for tools that would support their transition to a discussion about specific viruses, they conditions they cause and their expected symptoms and time course. This they felt would allow them to focus on providing useful expectant symptom management (what helps and what doesn't) advice and anticipatory guidance. Clinicians expressed the need for pathogen-specific educational handouts that describe expected symptoms, when they usually start during the illness and how long they will last. For example, "you will have cough for ~12-14 days, fever for 3-4 days", or "when you get red, goopy eyes from your adenovirus, you don't need to come back for antibiotic eye drops". Further, they thought such a timeline would

allow them to educate patients about what to watch for, “if you develop signs X, Y and Z, it would suggest the development of a complication and you should be seen again.”

Suggestions from Clinicians About Ways to Improve the System

Preferred delivery method: Our sample of clinicians preferred to have the surveillance information summarized for them in the form of pre-digested bullet points followed by a summary graph of the various pathogen’s epidemic curves embedded in an e-mail. Most preferred to have a more detailed dashboard attached to the e-mail that could be accessed as needed for questions not addressed in the high level summary. Pushed (as opposed to pulled information is preferred by most of our users). E-mail works well for most, many wanted on their phones in the form of a smart phone application. Others liked the ability to pull web site up in exam room and making it part of the discussion, but were frustrated if the site took too many clicks to access and the visualization wasn’t ready to be interacted with / used for this discussion immediately upon loading (e.g., they had to select parameters before graphs were displayed).

USER REQUIREMENTS SOLICITED FROM PARENTS OF PEDIATRIC PATIENTS

Parents in our focus groups were enthusiastic about the concept of GermWatch. We were able to solicit several concrete suggestions about how construct a system that would meet their information needs. Several suggested that it would be useful to have past years’ data so that they might prepare for what would be coming around at certain times of year and know what times of year to avoid very public areas and crowds. Most expressed frustration with trying to use web-based search engines to find medical information and said that they would go online and look at the GermWatch site if it was tailored for parents, it was updated, and it included descriptions of the viruses that were going around. Several voiced that audiovisual aids to help understand symptoms – “‘this cough sounds like this, wheezing sounds like this”, or “videos of children having trouble breathing would help.” The majority were interested in having access to information about the natural history of various infections – what to expect as the illness progresses, timetables for the progression, future symptoms to be on the lookout for – and resources describing childhood illnesses. Several voiced that having something to read in the waiting room would be helpful for preparing for their visit and that handouts, including the kind of virus and a list of symptoms would help them manage the illness better. Some agreed it would be nice to know what’s going around in their area specifically. “Can I know what is going around at my school?”

Many parents were interested in accessing an online comment site or local blog where parents could exchange experiences and insights for each other’s benefit. The parents thought this could be linked to the GermWatch site and other local medical information for parents to find and access. An additional theme was interest in having all this information all presented in one easily accessible place with clear instructions -- actionable advice -- for before seeing the doctor and after seeing the doctor. Several also mentioned the increasing role that their mobile phones were playing in accessing information and healthcare resources, with some specifically asking whether there would be an “app”.

RESULTS

This section provides details the tool development and system refinements that resulted from our end user engagement

DEVELOPMENT OF PHYSICIAN-FACING TOOLS

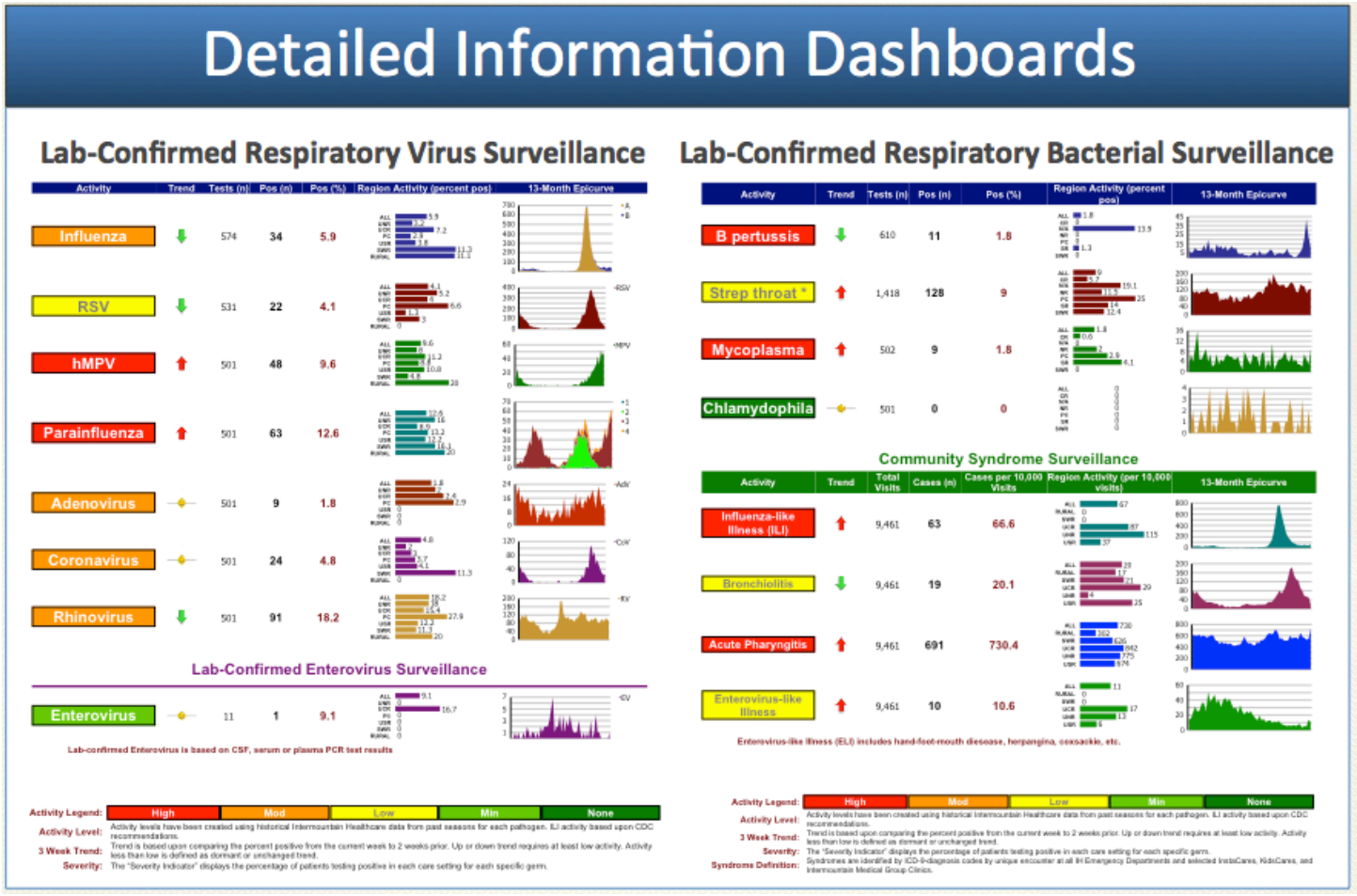
Dashboard Development

To enhance an infectious disease summary dashboard to provide key information about regional infectious disease activity that meets the needs of administrators, clinicians and public health, we analyzed the content of current reports and interviewed users (administrators, clinicians, infectious disease experts and epidemiologists) to understand their goals and tasks when using the

system. Using total and % tests positive by week, we developed pathogen-specific activity thresholds by analyzing historical outbreaks of 12 respiratory pathogens various pathogens. Our analysis led to development of a set of dashboard elements presenting pathogen-specific indicators: activity (None, Minimal, Moderate, Heavy, Intense), trend (5wk, 1yr, 5yr), severity (% inpatient and ICU) and regions affected. [2]

To address the request for information about gastrointestinal pathogens, we incorporated similar data on 7 gastrointestinal pathogens that are routinely tested for in our laboratories.
To address the request for better measures or signals for assessing the magnitude of various outbreaks in the community, we developed surveillance summaries for 5 syndromes of interest – Influenza-like illness, Bronchiolitis, Acute Pharyngitis, Enterovirus-like illness and gastroenteritis – using ICD9 coded visit data from ambulatory care facilities. [3]

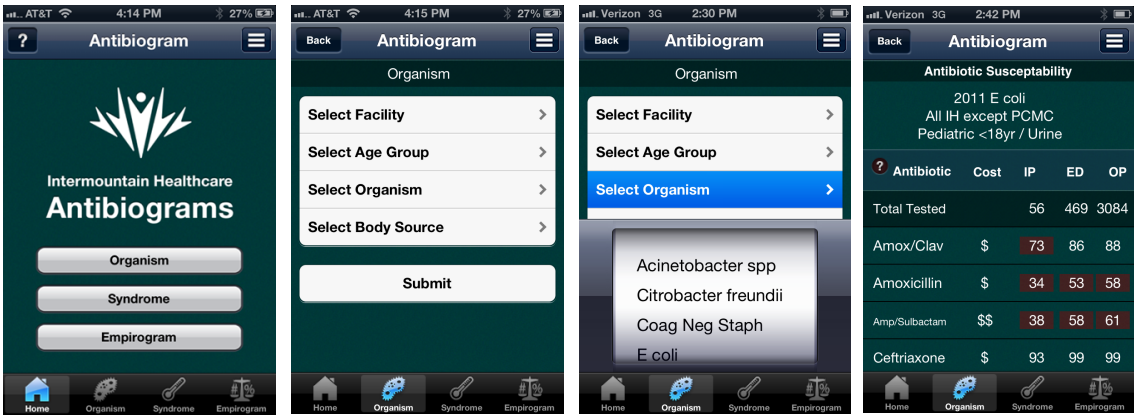
The current dashboard report (Sample Available from www.GermWatch.org/dashboard) was developed using IBM's Cognos 8 Business Intelligence platform and runs automatically on a weekly basis. The PDF report is pushed via burst email to key administrators, uploaded to the GermWatch physician web site and attached to the "GermWatch Weekly Disease Update" email sent to over 430 clinicians.



Antibiogram development – Pocket Cards and Mobile App

To make antibiogram information more readily available to ambulatory providers, PDF versions of the current pocket card antibiograms (printed on trifold card stock so they can be tucked in a lab coat pocket) readily available on the web, we created a web page dedicated to antibiograms as part of the physician GermWatch web site. Antibiograms were published for all of the major hospitals. To support access to antibiogram data, including that for ambulatory patients, we developed a smart phone application for the iOS operating system. [7, 10] The current application has three sections: Organism, Syndrome and the Empirogram. The Organism section includes cumulative susceptibility results by specific pathogen similar to data commonly found on facility pocket cards. The application

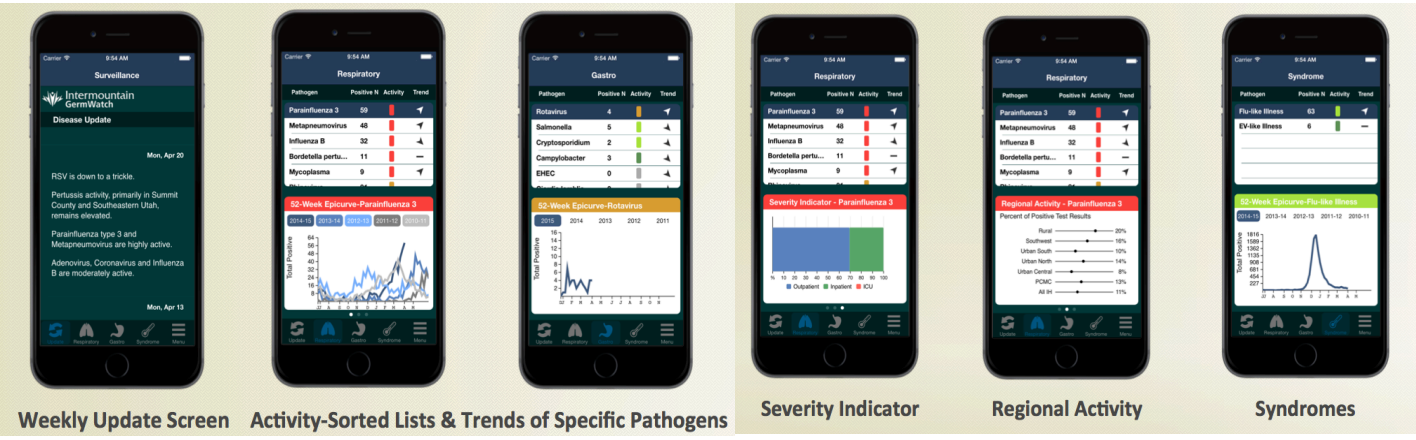
provides additional groupings not commonly found including age group (adult versus pediatric) and patient location: emergency dept (ED), inpatient (IP), outpatient (OP). After selecting the Organism section, you can specific your facility, the age group (adult versus pediatric), the organism you are interested in and the body source (urine versus non-urine). Non-urine isolates are from any body source other than urine. Based on your selections, the app will display a list of antibiotics, their relative costs and susceptibility for the selected bacteria. Where possible, data from three different patient locations – Inpatient (IP), emergency dept. (ED), outpatient (OP) – is provided. Pick lists



throughout the application are populated based on what data is available in the database. One analysis revealed significant differences in the susceptibility of pathogens isolated from pediatric patients in hospital vs. ambulatory settings. [1, 6]

Development of Mobile App Version of the Surveillance Dashboard

Following the development of the Antibiogram mobile application, we turned our attention to the development of a mobile version of the GermWatch surveillance dashboard. The app includes several components. A companion update web-based utility allows a system administrator to publish the bullet point update and indicate if it is a particularly important alert. The 'Respiratory', 'Gastrointestinal' and 'Syndrome' sections provide a list sorted on the basis of activity (high to low) with number of cases seen in the past week, the current activity level and the trend. User can view previous season/years activity and by swiping the graph, they can view regional activity and severity indicators similar to those displayed of the dashboard report. [11]



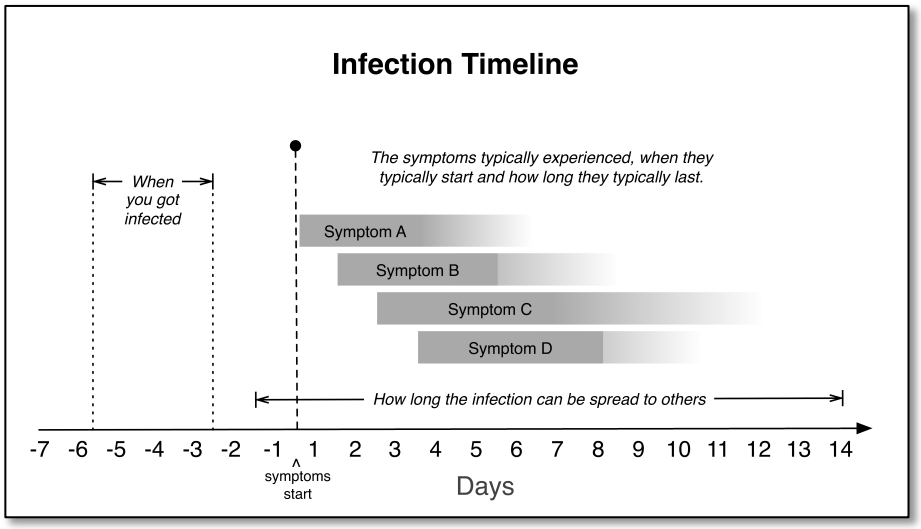
DEVELOPMENT OF A CONSUMER FACING WEBSITE

To address the information needs of healthcare consumers, we developed a public facing website (www.GermWatch.org) designed based on the feedback we received from parents/patients and input from clinicians. The site went live in fall of 2012. The home page provides high-level

summary of disease activity at the state level. Germ-specific pages provide: an overview of the pathogen; its seasonality & current epidemic curve; typical signs & symptoms; 'what can I do today' advice; figures depicting the infection period (see below); contagiousness; and links to educational content on related conditions (see pathogen-specific handouts below). [8, 11] Since it's launch, the site has had >150,000 total visits, averaging ~43,500 visits a year so far.

Development of a Visual Aid to Support Discussions About Expected Illness Course

Both providers and parents of patients told us there was a need for a visual aid to help users understand the time course and typical symptoms associated with various germs. A review of existing education sources, suggested this type of tool had yet to be developed. Based on this input, we developed a set of graphics – Infection Timelines – based on a review of published literature from trusted sources like the RedBook, CDC and the primary literature on various pathogens. The graphics convey information about the incubation period, contagious period, most common symptoms and their typical duration. A 'tutorial version' is provided here and actual timelines for multiple pathogens are available from the GermSchool section of the public GermWatch site (www.GermWatch.org).[8]

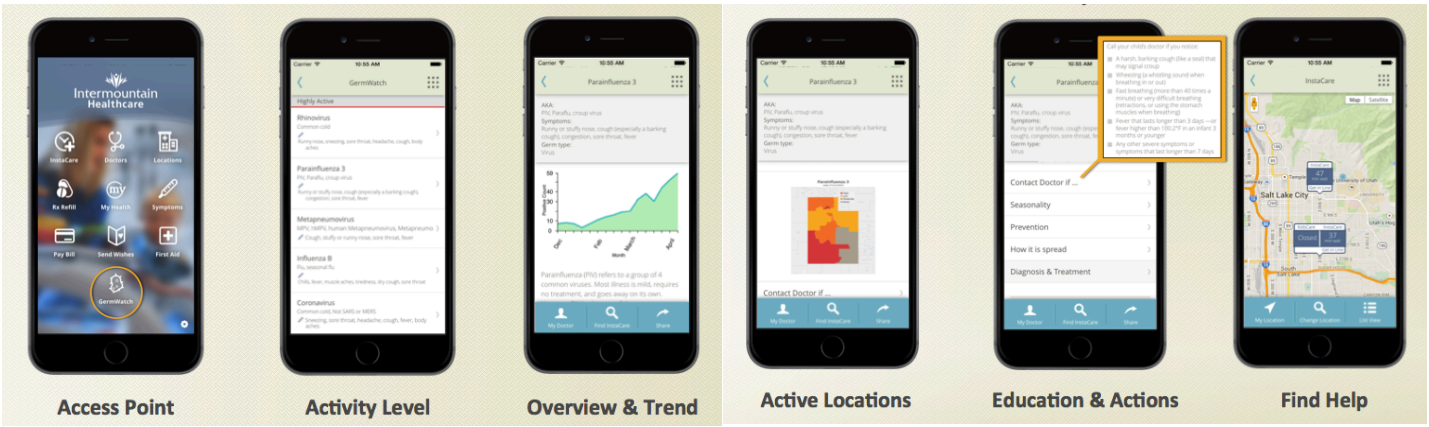


Making Pathogen-specific Handouts Readily Available

Both providers and parents of patients told us there was a need for patient education handouts that were more pathogen-specific. To meet this need, we sought out pathogen-specific handouts from publicly available sources (e.g., CDC, Medline Plus, KidsHealth), content providers with whom Intermountain has a contractual partnership and from the library of Intermountain's own internally developed content. These were made available as links on the individual pathogen GermSchool pages. We also set-up a process by which popular handouts could be printed in advance and stored in an alphabetically sorted rack of file folders on a conveniently located wall or file cabinet in the clinics. These two processes – making handouts available in line with the electronic GermWatch resource and having common handouts relevant to ongoing outbreaks at the ready – was very popular with the clinicians and, anecdotally, increased their efficiency.

PUBLIC FACING SMARTPHONE APPLICATION

In response to suggestions/requests from parents to make this information available on mobile phones, we developed a public facing application. The GermWatch content, similar to what is on the public facing web site, is available via an Applet within he Intermountain HealthHub container application. One compelling feature of this container application is the ability to get inline for an acute care visit by clicking on a 'find an InstaCare' button at the bottom of the page. [12]

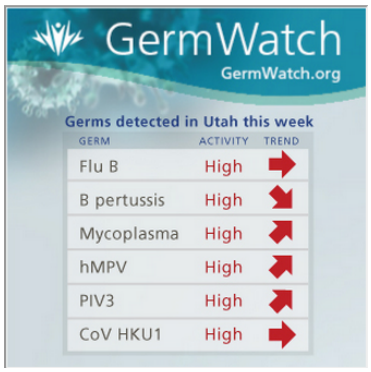


Since it's launch in July 2014, this applet has been launched ~24,000 times and is the 4th most popular app function of the 10 offered in the HealthHub container application.

MEDIA PARTNERSHIP AND USE OF SOCIAL MEDIA

Parents expressed an interest in accessing an online comment site or local blog where parents could exchange experiences and insights for each other's benefit and suggested integrating GermWatch information into local news media and social media. In response, we formed a partnership with a local news corporation and integrated GermWatch into Intermountain's social media activities.

We partnered with a prominent local news outlet to start getting the "viral weather report" into the news. This partnership has two components; the first being an agreement to have clinical experts (infectious disease doctors, pediatricians etc) available to do stories about ongoing outbreaks and various infectious disease topics. The second being an effort to integrate a GermWatch widget into the news media's web site. This partnership has lead to news stories that generated significant interest and traffic to the GermWatch web site, which suggest that this approach can play an important role in delivering quality information from a trusted source to a broad audience of potential healthcare consumers.



Building on Intermountain's social media presence, specifically the Intermountain Mom's FaceBook network, we conducted several of live chats where topics of interest to parents related to current infectious disease outbreaks. For example, with the fall 2014 outbreaks of Parainfluenza and RSV, we conducted chats about these viruses and the conditions they cause – croup, bronchiolitis – that reached >12,000 people. A recent post in the summer 2015 about an outbreak of enterovirus (hand-foot-mouth, herpangina) reached almost 30,000 moms. This level of interest was far more than we expected and demonstrates the potential power of our approach to inform, guide and educate parents about common infectious diseases.

STATUS OF SYSTEM EVALUATION

Given the breadth, depth, and complexity of all the refinements and new tool development we accomplished during the project period, we did not have a cohesive intervention package to deploy and evaluate in the manner we proposed in the grant (Specific Aim 4) during the time period allotted for the project. As of the time this final report was submitted, the expanded and refined set tools were still being modified to support this study. Specifically, we were integrating utilization tracking functionality that was not included in the early versions of the various components of the system (i.e., ability to track who opens the weekly e-mails and accesses the surveillance dashboard reports, ability to see who has installed the mobile application, how often they access it and what sections they

access). The data collection system is in place for the outcome measures including antibiotic and diagnostic test utilization and survey instruments have been developed. We have secured additional internal funding to support this evaluation and anticipate performing it during the next respiratory viral season (fall / winter 2015-2016). The results of this evaluation, when published, will acknowledge the original AHRQ funding.

We were able to perform an evaluation of the current user base with respect to clinician acceptance and use of the current tools. In the Winter of 2014, a survey was emailed to 463 Intermountain clinicians that have opted in to use GermWatch. 121 clinicians responded, or over 25 percent of clinical users. An overview of how often and why they use GermWatch was obtained: 95% use GermWatch one or more times per week, 30% use GermWatch one or more times per day and 82% agree that their patients expect them to know which germs are active, or going around. 90% or greater agree that GermWatch is useful for: enhancing clinical practice, diagnosing acute respiratory infections (ARIs), discussing the diagnosis & management of ARI and describing treatment decisions. 65% or greater agree that GermWatch is useful for: increasing clinical efficiency, deciding whether to order diagnostic tests, deciding whether to prescribe antivirals and deciding whether to prescribe antibiotics. The responding clinicians felt the most efficient way to receive GermWatch reports was, in descending preference: Email, Smart phone app, Electronic Health Record, Website, Text messages and Twitter.

CONCLUSION

Over the 5+ years of this project, we developed a collection of health information technologies designed to meet the information needs of clinicians and patients with respect to acute respiratory tract infections. These technologies include: an automated data collection and warehousing system; various visual analytic and information displays; a provider-facing web site and iOS application; an email distribution list comprised of ~500 individuals (clinicians, public health partners, school nurses, HR managers, healthcare facility administrators) who receive weekly updates; a public-facing web site and companion cross-platform mobile application; a partnership with local news media to disseminate the “viral weather report”; and a process for harnessing the power of social media to engage consumers in discussion/education about upcoming and ongoing outbreaks. Preliminary survey results and data on the ongoing use of the various tools strongly suggest that both clinicians and the public are eager to have access to high quality information from a trusted source. GermWatch provides a compelling demonstration of how modern technologies can be combined to meet this information need. Forthcoming evaluations of the systems impact on provider and patient satisfaction as well as rates of antibiotics prescribing and diagnostic test utilization should yield important knowledge about the impact these technologies can have on improving the quality of care for ARI in ambulatory settings.

LIST OF PUBLICATIONS AND PRODUCTS

PUBLISHED WORKS

1) Dahle K, Korgenski EK, Gesteland PH. Spectrum and Antibiotic Resistance of Uropathogens Isolated from Hospitalized and Ambulatory Clinic Patients in a Large Integrated Care Delivery System: The Case for Developing Antibiograms Suitable for Use in Adult and Pediatric Ambulatory Practice [Abstract]. *Proceedings of the Pediatrics Academic Societies' 2010 Annual Meeting*; 2010 May; Vancouver, Canada; E-PAS20102865.532

2) Gesteland PH, Korgenski EK, Pavia AT, Byington CL. Development of a Viral Respiratory Activity Information Dashboard: Supporting Outbreak Response and Clinical Decision Making through Information Visualization [Abstract]. *In: Platform Session: Infectious Disease: Virology: Proceedings of the Pediatrics Academic Societies' 2011 Annual Meeting*; 2011 May 2; Denver, CO; E-PAS2011:3660.5.

3) Korgenski EK, Boulton R, Gesteland PH. The Accuracy of Detecting ILI (Influenza-like Illness) Using Electronic Surveillance in the Intermountain West [Abstract]. *In: Poster Session: Epidemiology: Proceedings of the Pediatrics Academic Societies' 2011 Annual Meeting*; 2011 May 2; Denver, CO; E-PAS2011:4516.241.

4) Leecaster M, Gesteland PH, Greene T, et al. Modeling the Variations in Pediatric Respiratory Syncytial Virus Seasonal Epidemics. *BMC Infectious Disease* 2011 Apr 21;11(1):105.

5) Gesteland PH, Livnat Y, Galli N, et al. The EpiCanvas Infectious Disease Weather Map: An Interactive Visual Exploration of Temporal and Spatial Correlations. *Journal of the American Medical Informatics Association*, Nov-Dec;19(6): 954-9.

6) Dahle KW, Korgenski EK, Gesteland PH. Clinical Value of an Ambulatory-based Antibiogram for Uropathogens in Children. *Journal of the Pediatric Infectious Disease Society* 2012; 1(4): 333-336.

7) Gesteland PH, Gutke B, Stambaugh K, Vallamreddy K, Korgenski EK. Development of a Mobile Antibiogram Application To Support Empiric Antibiotic Prescribing across the Infection, Age and Site of Care Spectrums. [Abstract]. *In: Poster Session: Infectious Diseases: Proceedings of the Pediatrics Academic Societies' 2013 Annual Meeting* 2013 May 5; Washington, DC; E-PAS2013:4516.241. (Available at: www.germwatch.org/antibiograms)

8) Gesteland PH, Scott K, Smith G, Reynolds C. GermWatch Public: A Web-Based Resource Providing Parents and Patients with Timely Temporo-Spatial Information about Regional Infectious Disease Activity in Utah. [Abstract]. *In: Poster Session: Infectious Diseases: Proceedings of the Pediatrics Academic Societies' 2013 Annual Meeting* 2013 May 5; Washington, DC; E-PAS2013:1534.469. (Available at: http://www.germwatch.org/public-site)

9) Gesteland PH, Korgenski EK. GermWatch: Health Information Technology Supporting Population-Based Clinical Practice for Acute Respiratory and Gastrointestinal Tract Infections in Utah. [Abstract]. *In: Poster Session: General Pediatrics & Preventive Pediatrics: Proceedings of the Pediatrics Academic Societies' 2013 Annual Meeting* 2015 April 27; San Diego, CA; E-PAS2015:3935.729. (Available at: www.germwatch.org/overview)

ELECTRONIC RESOURCES FROM STUDY

10) Intermountain Physician GermWatch App for iOS. Gesteland P and Stambaugh K. Intermountain Healthcare. (requires username and password from Intermountain) https://itunes.apple.com/us/app/intermountain-physician-germwatch/id863270238

11) GermWatch Public Facing Web Site. Gesteland P. and Smith G. Intermountain Healthcare. http://www.GermWatch.org

12) Intermountain Health Hub App Featuring GermWatch for the Public. Gesteland P. and Smith G. Intermountain Healthcare.
iOS: https://itunes.apple.com/us/app/intermountain-health-hub/id846934886
Android:
https://play.google.com/store/apps/details?id=org.intermountainhealthcare.consumerlauncher

INCLUSION OF PRIORITY POPULATIONS IN RESEARCH

Since the primary objectives of this project were the development and refinement of various Health Information Technologies to Support Population-Based Clinical Practice, there was no specific target enrollment for pediatric patients against which to report progress. The tools we have developed (and will be further evaluating) address conditions highly prevalent among pediatric patients in any given year. Clinics from the Intermountain Healthcare system see >200,000 patients (~40% pediatric) for Acute Respiratory Infections (ARI) each year. That translates into >80,000 pediatric patients a year being seen in the system. Therefore, we expect that future studies assessing the impact of these tools will readily demonstrate that we have included and in fact directly addressed this priority population.